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(National Commission for Space Research)

SPACE RESEARCH IN ARGENTINA

REPORT TO COSPAR
(Buenos Aires, May 10-21, 1965)

NATIONAL COMMISSION FOR SPACE RESEARCH
BUENOS AIRES

1965

NATIONAL REPORT ON SPACE RESEARCH IN ARGENTINA

NATIONAL COMMISSION FOR SPACE RESEARCH

AERONAUTICS ADMINISTRATION

Buenos Aires, May 1965

SPACE RESEARCH IN ARGENTINA

32273 */1

A government report on Argentina's space research, in cooperation with NASA, covers the present status and future projects in the field of high-altitude measurements and earth-based observations, by probe rockets, balloons, and artificial satellites. Emphasis is on measurements in the sporadic E-layer of the ionosphere, including ion, electron, and temperature measurements. Other fields cover experiments with sodium and other luminous clouds ejected from rockets, cosmic radiation, observations of auroras, radioastronomy, meteorology, geodesy, satellite tracking, etc. A list of launchings for the year 1964 is given.

Author

INTRODUCTION

During 1964, activity in the field of space research has continued and intensified in Argentina, in comparison with previous years. In particular, two new series of rocket launchings have taken place: one for the study of atmospheric currents by means of luminous wakes and the other for investigations on the sporadic E-layer of the ionosphere. In addition, the program of balloon measurements as well as the theoretical and practical developments and educational activities have continued. On the other hand, new cooperative programs are under consideration and bases will be established for initiating a synoptic meteorological program with rockets.

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* Numbers in the margin indicate pagination in the original foreign text.

Numerous activities with respect to space research have been conducted within the framework of the programs prepared for the International Year of the Quiet Sun.

This report, covering the above activities, has been subdivided into the following sections:

1) Measurements at High Altitude;

2) Earth-Based Observations;

3) Theoretical Investigations;

4) Investigations and Technological Developments;

5) Educational Activities;

6) Present Projects.

I. MEASUREMENTS AT HIGH ALTITUDE

1.1 Measurements by Rockets

1.1.1 Experiments with the Sodium Cloud

The cooperative program for studies of winds and turbulence in the upper atmosphere by means of luminous trails ejected by rockets is being continued, with three launchings which took place on November 4, 5, and 6 of 1964, all of them successful. The present report includes samples of the obtained photo- /2 graphs. The sodium trails ejected by the Centaur rockets were photographed with eight cameras, erected at various distances from Chamical Base, at the following locations: Northern Zone: La Rioja, Puerto Alegre, Cebollar, Punto X, Chumbicha; Eastern Zone: Recreo, Kilometer 931, Puerto Nuevo. The observation posts in La Rioja, Chumbicha, Recreo, and Kilometer 931 were considered "main tracking stations", while the remainder were classified as "slave tracking stations".

In each of these stations, a K-24 camera with special mounting and Kodak

Tri-X film is used, equipped with an Aerocon and a Wratten 23A filter. The main stations are provided with quartz clocks, synchronized with official Argentine time.

A high-frequency communications network is established between the main stations and the headquarters of the Command at Chamical Base; VHF telephone lines are used for communication between the main and secondary tracking stations, specifically for the purpose of synchronization.

In addition, the Eaker-Num camera of the Optical Satellite Tracking Station of Villa Dolores (Córdoba) is used for obtaining a detailed recording of the sodium cloud by turbulence studies.

The date and hour of each launching and the approximate altitude for each rocket were as follows:

December 4, 1964 - 08:31 ZT* - 175 km

December 5, 1964 - 23:16 ZT - 179 km

December 6, 1964 - 08:31 ZT - 176 km.

All launchings were successful, and the obtained photographs were of excellent quality. Argentine institutions participating in this project were the University of Cuyo (Faculty of Engineering), University of Buenos Aires (Faculty of Engineering), University of Tucumán (Faculty of Science and Technology), and the Aeronautics Administration.

1.1.2 Ionosphere Experiments

Within the limits of a cooperative program between NASA and the National Commission for Space Research, two Nike-Cajun rockets were launched from Chamical Base, for probing the lower ionosphere layers, specifically the sporadic

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* Zone time.

E-layer. The scientific objectives of these launchings included the initiation of a direct and systematic study of the diurnal and nocturnal fluctuations, so as to verify existing theories and to obtain a clearer definition of the physical processes produced by the various types of E_s echoes. With this purpose, /3 each of these two probe rockets was launched whenever the ionograms, obtained with the vertical probe at the launching base, exhibited E_s echoes of the h type.

The specified goal of the first launching (December 1, 1964; 16:20 UT) was the measuring of the electronic density (CW method), ionic density (ion probe), and electronic temperature (electron probe). The second launching (December 4, 1964; 18:06 UT) made measurements of electronic density and temperature and of the integrated solar flux (UV-probe). In both launchings, useful data were obtained.

With the object of obtaining a clearer concept on the E_s fluctuations, a project was prepared for obtaining more information by new launchings of probe rockets equipped with ionospheric space payloads.

The participants in this program were the University of Tucumán (Faculty of Science and Technology), the University of Buenos Aires (Faculty of Exact Sciences), and numerous agencies of the Aeronautics Administration.

The payloads and equipment for the earth-based stations were designed and mounted by Argentine personnel at the Goddard Space Flight Center (NASA), with components furnished by NASA.

1.2 Balloon Measurements

The Cosmic Radiation Group of the University of Buenos Aires is continuing its program of systematic measurements, initiated during the previous year. For this, meteorological balloons of low weight are used. In all, 20 flights will

be made, 15 of these from Buenos Aires and the others from Chamical Base. The series includes simultaneous monthly flights, performed in cooperation with European groups integrated in SPARMO (Solar Particles Activities Research and Monitoring). These balloons use a standard low-weight detector system, which measures the total horizontal component. In five of the flights, a scintillation counter is used, for measuring the additional X-radiation flux originating in the emission of electrons from the inner Van Allen belt.

The Cosmic Radiation Group of the University of Tucumán has outlined a program for determining the intensity of electrons emitted by the inner Van Allen belt, originating in the X-rays produced by the deceleration of electrons. This program was originally initiated by the Group of the University of Buenos Aires, as given in previous Government reports. The Institute of Physics of the University of Tucumán has scheduled to study the anomaly, to establish a cor- /4 relation between intensity of emission and geomagnetic phenomena, and to obtain an emission spectrum.

Balloon launchings were made from Tucumán, Chamical Base, Buenos Aires, and Matienzo Base (Antarctica).

At present, the program of measurements is being continued and it is hoped that the electron emission spectrum will be obtained by means of measuring the photon spectra. For this reason it is of great importance to measure the production of photons at high altitudes.

The final object is to obtain the electron emission spectrum from the photon spectrum, measured at certain atmospheric depths.

The long-range project is to develop a program of systematic measurements of the intensity and spectra of photons and to correlate these with geomagnetic phenomena.

The first equipment developed for this program was an X-ray detector with a Na I (TL) crystal, combined with a phototube into an integral instrument with an energy level below 20 Kev. The telemetering equipment consisted of an FM-FM 136 mc/sec transmitter (power: 100 mw) with subcarrier channels of 1.8 and 3.7 kc/sec. The second payload developed consisted of the same receiver plus an amplitude discriminator with which it was possible to obtain two channels, one of 15 - 60 Kev and one above 60 Kev. The power of the receiver, in this case, was 160 - 180 mw.

This is the present payload which is being used for systematic measurements of photon intensity. In all cases, the pressure measurements were performed by an Oland cycle (University of Minnesota).

Flights were also made with balloons made of neoprene and polyethylene, manufactured at the Institute of Physics of Tucumán.

II. EARTH-BASED OBSERVATIONS

2.1 Cosmic Radiation

The Cosmic Radiation Group of the University of Buenos Aires continues operation of the three Observatories (Buenos Aires, Ushuaia and Mina Aguilar, with the latter being operated by the University of Tucumán), equipped with standard neutron monitors (IGY model). During the summer of 1964 - 1965, a project was developed for measuring the latitude effect in the Southern Hemisphere, by means of a neutron monitor installed on board the icebreaker General San Martín. Data within the range of 11.4 to 0.7 Gv of strength of the geomagnetic section were obtained (the data are in the process of evaluation).

At present, the electronic system of a neutron supermonitor is under construction (18-NM-64) which will be installed within a few months at the Uni- /5

versity City of Buenos Aires.

The Cosmic Radiation Laboratory of the Institute of Mathematics, Astronomy, and Physics (IMAF) of the University of Córdoba initiated, on July 1 of 1964, systematic measurements of the nucleonic component of cosmic radiation, by means of a neutron monitor of the Simpson type.

2.2 Ionosphere Observations

2.2.1 Vertical Sounding

The Laboratory for Ionospheric Investigation of the Navy (L.I.A.R.A.) is continuing vertical soundings in Buenos Aires, Trelew, Ushuaia, and Deception Island (Antarctica). This Institute also will cooperate with Chamical Base in the launchings of ionosphere rockets in December, installing and operating a vertical probe of the TRIO type, designed in the Laboratory.

In the Argentine Antarctic Institute (I.A.A.) a program was developed for ionosphere soundings at 15-minute intervals, using a vertical C-4 probe, at the General Belgrano Base in Antarctica, continuing similar observations started in 1957 at Ellsworth.

The Ionosphere Station of the University of Tucumán (E.I.TUC) has continued with its program of vertical soundings at 15-minute intervals as well as at 5-minute intervals during the World Days. The object of this project is the study of the ionospheric fluctuations in the equatorial and subequatorial region, making use also of data obtained by other organizations.

2.2.2 Satellite Observations

The L.I.A.R.A. also has developed a program of special observations of the ionosphere satellite "Alouette" from stations in Buenos Aires, Trelew, Ushuaia,

and Deception Island. In addition, the Ushuaia station has cooperated in the recording of signals emitted by the S-66 ballistic satellite.

In Tucumán, an average of two daily recordings has been obtained since launching of the S-66 ionosphere satellite on October 9, 1944, using the special receiver equipment installed at the ionosphere station of Tucumán, under /6 contract with the CNIE. The object of this program is the study of variations in the equatorial ionospheric anomaly, by means of an analysis of the total electron content of the ionosphere. The method used is the coupling with the Faraday magneto-optical rotation.

2.2.3 Investigations Using VLF (Very Low Frequency) Transmissions

In the Ionosphere Station of Tucumán, investigations on transequatorial VLF propagation are being continued, with measurements of the variations in phase and amplitude. In 1964, a continuous recording of NBA (24 kc/sec) and of WWVL (20 kc/sec) was made, which latter was obtained during the period that the NBA was not in operation.

2.3 Aurora Observations

The I.I.A. has developed a program of visual aurora observations at intervals of not more than 15 minutes, during favorable periods, from the General Belgrano Base in Antarctica. During this same period, a photographing of the entire sky yielded 1230 m of film, with exposures at intervals of 1 min. This information will be used for preparing "ascaplot" and "auroraplot" diagrams, as a contribution to the synoptic study of the auroral morphology, within the programs of the International Years of Quiet Sun.

2.4 Optical Satellite Tracking

During the year 1964, The Optical Satellite Tracking Station of Villa Dolores photographed more than 4022 satellite passes (the Station operated on the basis of an agreement between the Smithsonian Astrophysical Observatory and the CNIE).

This information is being used at present for studying the variations in /7 the earth's magnetic field, atmospheric density, solar perturbations, and for refining geodetic measurements and other phenomena yielding information on orbits and satellites. The Station also participated in programs in the field of photography of geodetic satellites, which has lately been expanded. At present, plans are under study for coordinating this activity with the activities initiated at the University of Cuyo (Faculty of Engineering of San Juan), in cooperation with the CNIE.

The Argentine Astrophysical Observatory has obtained a total of 337 photographs of comets, which are being used for determining their structure and motion. Of specific interest were the photometric observations for determining their brilliance, using specifically designed filters and special photographic techniques. As mentioned before, the optical tracking station cooperates with the CNIE in taking photographs of sodium clouds formed by probe rockets launched from Chamical Base, about 240 km northeast of the Station. This communications system of the Station, which is a part of the world net of NASA, was used by the CNIE for coordination with other launching bases. Of the three launchings made, two were photographed by means of the Baker-Nunn camera, with satisfactory results; however, the third launching could not be photographed because of cloud cover over the Station. In addition, the work in the program of star tracking, developed in conjunction with the radiotelescope of Fodrell Bank, is being

continued.

2.5 Radioastronomy

In this field, the installation of the 30-meter radiotelescope of the /8
National Radio Astronomy Institute in the vicinity of Pereyra Iraola, not far from Buenos Aires, is almost finished. The radiotelescope will be used for solar and galactic investigations.

III. THEORETICAL INVESTIGATIONS

3.1 Aeronomy

The data obtained during the launchings of the sodium cloud of November 1964 have been analyzed, and a report on the results has been prepared. Considerable importance has been given to the problem presented not only of the analysis of the locally obtained data but also to the problem of coordination of an analysis of the world-wide information obtained with experiments on luminous clouds. In this respect, the creation of a National Center has been under study, which would be responsible for the reduction of all pertinent data.

IV. TECHNOLOGICAL AND DEVELOPMENT INVESTIGATIONS

4.1 Probe Rockets

The CNIE is continuing to give full support to the development of probe rockets and accessory equipment, serving as tools for scientists interested in space research. The Institute of Aeronautics and Space Investigation (IIAE) - aside from the active support it has given to the ionosphere launchings of the sodium cloud which took place from Chamical Base - has also developed a series

of launchings with its own experimental vehicles. These launchings took /9
place from Chamical Base, Puente del Inca (Mendoza), and from Matienzo Base (Antarctica), thus covering a wide range of climatological conditions. Among the test launchings, there is a series of launchings of a "Dardo" (Dart) Rocket for Meteorological Investigations (DIM), now in the process of development and finally to be used as wind sensor (toward this end, a payload of 1.8 kg "chaff" has been provided). In addition, the work on launching of the meteorological rocket "Orion" is continuing, in agreement with the requirements presented by the CNIE.

4.2 Instrumentation

Work is being continued on the development of payloads for meteorological rockets and, specifically, for telemetry systems. The Radiation Laboratory of the IIAE has developed and designed radiation detectors for use in probe rockets. The detector consists of a NaI (TL) crystal, combined with a photomultiplier specifically designed for rocket flights. The Electronics Engineering Group of the University of Tucumán has developed an X-ray spectrometer with eight channels, with a telemetry similar to that used in the balloon projects, supplemented by the addition of a matrix to obtain a pattern of the information. In addition, instrumentation for rockets with solid-state detectors was developed, to be used for measuring electrons of 0.1 to 1.2 Mev.

V. EDUCATIONAL ACTIVITIES

One of the main objectives at present is that to promote the specialization of Argentine scientists and technicians whose main activity would be in the /10
field of space research. Special attention was paid to the creation of new

university courses in space science and technology. During the year 1964, the CNIE has continued its active support of universities and other research and development centers so as to enable advanced and graduate students to continue their studies and do specialized work in local institutes and in other countries.

The Latin-American School of Physics was established last July in the city of Tucumán, giving courses in magnetohydrodynamics, solar physics, magnetospheric physics, interplanetary plasma, and mechanical statistics, under the direction of foreign and Argentine scientists.

On the other hand, the organization has continued its support of congresses such as the Regional Assembly of A.I.S.Q. and the Interamerican Symposium on Space Investigations, which took place in Buenos Aires in August.

VI. PRESENT PROJECTS

6.1 Ionosphere

At present, the continuation of the NASA-CNIE program is under study, initiated with the launching of two Nike-Cajun rockets from Chamical Base in December 1964. These launchings are being considered only as the beginning of investigations that are to become more exhaustive and, specifically, will cover the following:

a) Two more daytime launchings, in the presence of type h-c E_s echoes, for measuring the electron and ion densities, the electron temperature, and the ultraviolet flux.

b) Two more nighttime launchings, on the E_s echo type I frequency, for measuring the electron temperature and density as well as the ion density. About 5 - 10 min after each launching, a determination of the wind profile, by means of the technique of

luminous clouds, will become possible. /11

It is believed that the data obtained by means of these launchings will permit a better understanding of many ionospheric phenomena.

In addition, it is planned to investigate the ionosphere conditions within the South Atlantic Anomaly, by launchings of rockets from a base to be established on the Argentine Atlantic Coast.

6.2 Aeronomy

The international series of launchings of luminous vapors will continue next June with the launching of a minimum of three probe rockets from Chamical Base. Two of these rockets will be equipped with payloads for the ejection of sodium, while the third one will have a payload of orthorhombic aluminum. If the conditions are favorable, it is hoped to fire the three rockets within a space of 10 hrs.

Also under consideration is the possibility of future launchings of probe rockets with payloads for measuring electron densities and producing luminous wakes.

6.3 Meteorology

The study of a cooperative program between NASA and CNIE for the launching of meteorological rockets is presently in its final stage. It is expected to obtain data on temperatures and winds, with the latter being measured by optical observation of metallized parachutes and chaff. The program will be initiated toward the end of the year with launchings from two bases in Argentina: Chamical and Comodoro Rivadavia (46 S) on the Atlantic Coast. Later, this will be supplemented by a third base, and eventually launchings of probes with weather rockets

from Matienzo Base in Antarctica are scheduled. It is expected to develop /12 regular and simultaneous series of launchings every three months and it is hoped that also other countries will participate in this program, so as to obtain data from as many bases as possible.

6.4 Cosmic Radiation

The program of balloon measurements is being continued and it is planned to initiate a program of measurements by rockets. With this in mind, the first step would be a launching, in the very near future, of small rockets for the testing of equipment adapted to detection and telemetry.

Other programs which are being studied at present include the launching of probe rockets to an altitude of 400 - 500 km, in the region of the South Atlantic Anomaly, equipped with solid-state detectors for electron and proton measurements and with photomultipliers for X-ray detection. Another possibility under consideration is to carry aloft a magnetic spectrometer, for determining the electron spectra.

6.5 Geodesy

At present, the realization of a program of geodetic studies, using artificial satellites, is under consideration; the training of specialized personnel is already underway, under the auspices of the Smithsonian Astrophysical Observatory.

LAUNCHINGS OF PROBE ROCKETS

(1964)

Designation	Date and Hour, UT	Type of Rocket	Payload	Objectives
AER 1/64	November 4 08:31	Centaur	Sodium	Determination of winds and turbulence in the upper atmosphere
AER 2/64	November 5 23:16	Centaur	Sodium	Determination of winds and turbulence in the upper atmosphere
AER 3/64	November 6 08:31	Centaur	Sodium	Determination of winds and turbulence in the upper atmosphere
ION 1/64	December 1 16:20	Nike-Cajun	Ion probe CW experiments Electron probe	Measurement of electron and ion densities and electron temperature in the E-layer of the ionosphere, in the presence of sporadics
ION 2/64	December 4 18:06	Nike-Cajun	Electron probe CW experiments UV probe	Measurement of density and electron temperature and the integrated UV solar flux in the E-layer, in the presence of sporadics

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Sitte, K.: Fireballs, Isobars and Extensive Air Showers.

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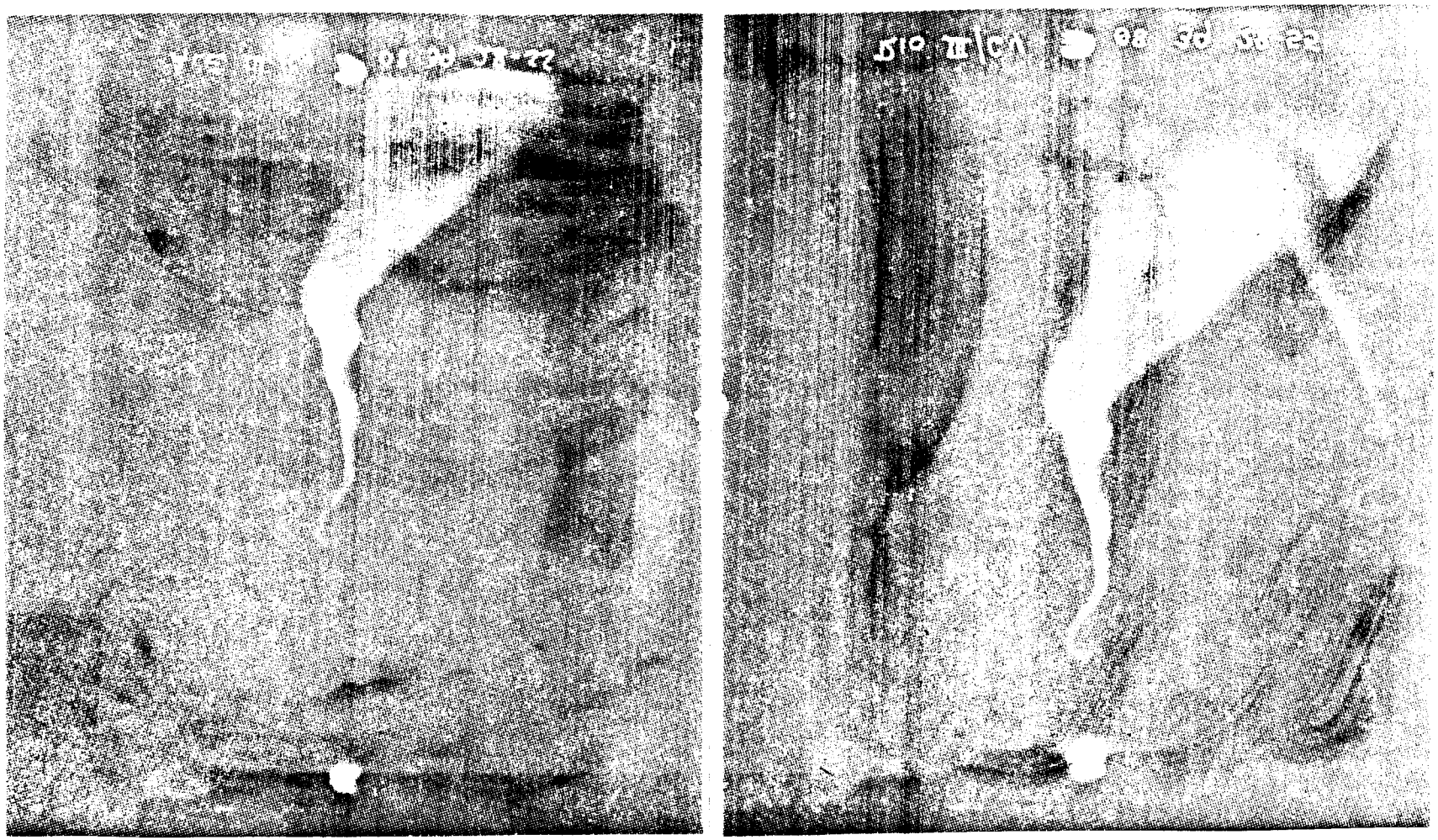
STEREOSCOPIC PAIR

SODIUM CLOUD



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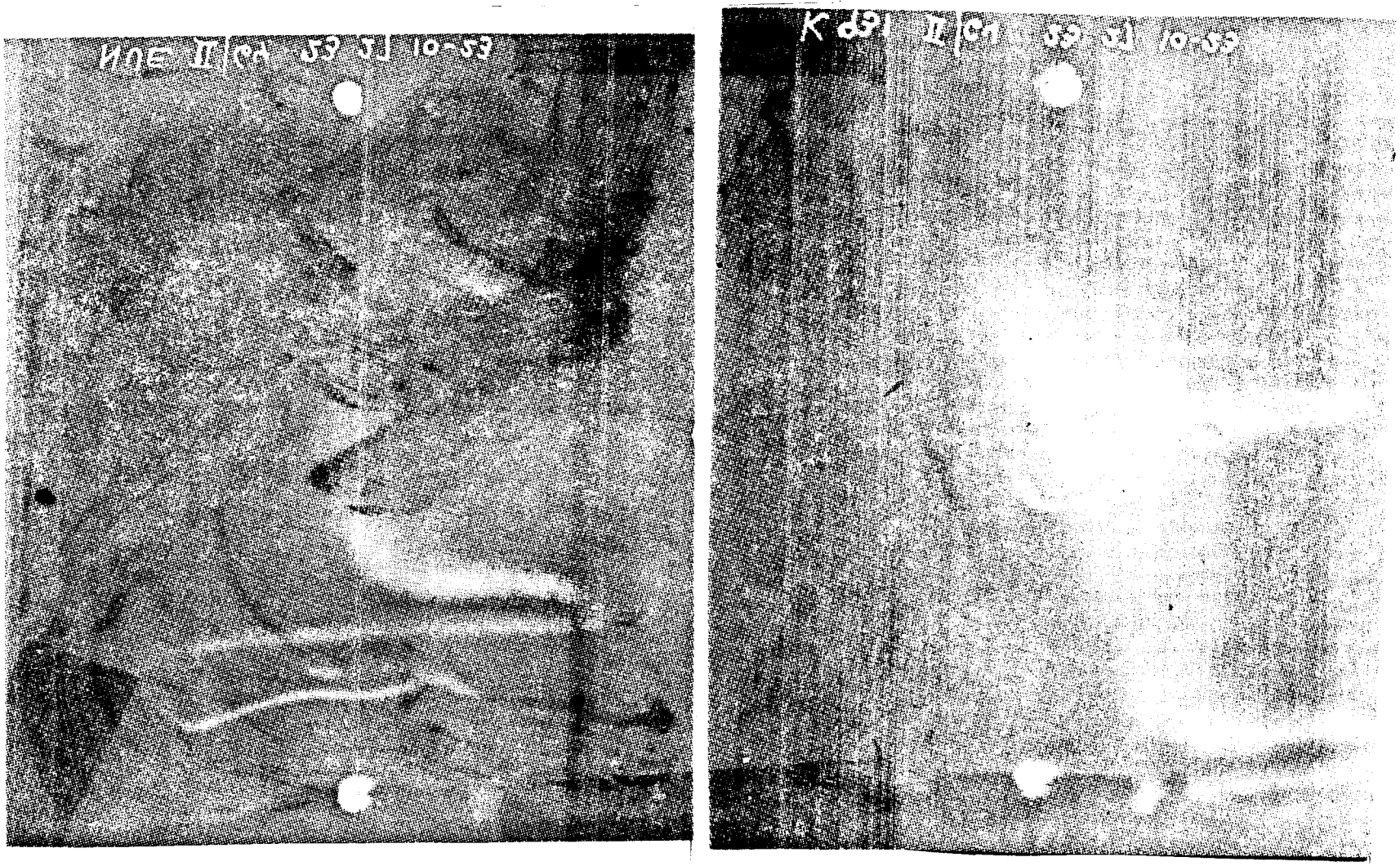

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INTERAMERICAN COMMITTEE FOR SPACE RESEARCH /18

In the city of Mar del Plata (Republic of Argentina) on the eighteenth day of the month of May of 1965, the following members and observers of the Interamerican Committee for Space Research, assembled (given in alphabetical order):

Argentina: Engineer Teófilo M.Tabanera; Commodore D.Humberto J.Ricciardi.

Bolivia: Dr. H.Ahluwalia; Engineer G.Mejía (Observers).

Brazil: Observer Dr. Abrahao de Morais and Dr. Fernando de Mendonca (Observer).

Chile: Dr. Alvial and Engineer Ramirez (Observers).

Peru: Engineer Romero.

In addition, Arnold Frutkin, the Director of the International Relations of NASA, participated as observer.

After an exchange of ideas, the following decisions were taken:

First - Designate a commission formed by Dr. Alvial, Dr. de Morais, and Engineer T.Tabanera to formulate the project of the statutes of the International Committee and to submit these for the consideration of the Committee members before July 1st of the current year.

Second - Call a plenary session at Chamical Base at the time of the next experiments, to discuss this subject.

INTERAMERICAN COMMITTEE FOR SPACE RESEARCH /19

In the city of Buenos Aires, capital of the Republic of Argentina, on the twenty-fifth day of the month of May 1965, the following members of the Interamerican Committee for Space Research, assembled (given in alphabetical order by countries):

Argentina: Engineer Teófilo M.Tabanera and Commodore D.Humberto J. Ricciardi; as observer, Dr. Aldo Cocca.

Brazil: Observer, Dr. Tomás Pedro Bun.

Peru: Prof. Jorge Mendoza Romero and Dr. Manuel del Castillo.

Uruguay: Engineer Hector Fernandez Guido; Prof. Gladys Vergara as observer.

In consideration of the assigned subjects, be it resolved as follows:

First - Ratify the agreement in the Extraordinary Assembly held in Mar del Plata on 18 May 1965, concerning the date of final formulation of the statutes of the Interamerican Committee for Space Research and the next session for discussion of these statutes. In this respect, the National Commission for Space Research of Argentina will confirm to the Committee the dates of launchings at Chamical Base, scheduled for the first days of the month of July of the current year.

Second - On motion of the Brazilian observer Dr. Tomás Pedro Bun, it is decided to establish the permanent seat of the Secretary of the Committee in the city of Buenos Aires and to call annual plenary sessions, rotating among the member countries of the Committee.

Third - It is decided to accept the proposition officially formulated by Dr. Manuel del Castillo, to hold the ordinary April plenary session of the Committee in the month of April 1966 in the city of Lima.

Fourth - It is agreed to also hold extraordinary sessions in the member countries of the Committee, at the occasion of other international meetings on the subject of space research.

Fifth - It is agreed to recommend to the members of the Statutes /20 Commission to consider the creation of working groups and special commissions, with the participation of the various member countries of the Committee, for formulating the general plans of the organization.

Sixth - On motion by Dr. Manuel del Castillo, it is resolved to have the Interamerican Committee for Space Research promote and patronize all studies and investigations to be made in Peru by Engineer Pedro Paulet, as precursor of astronautics in America, and to incorporate this subject matter, whose significance was specifically emphasized by all those present, into the program of the next meeting of the Committee.

There being no further business, the meeting is closed, delegating Dr. Manuel del Castillo, Commodore Humberto J.Ricciardi, and Dr. Aldo Cocca to edit the present minutes.